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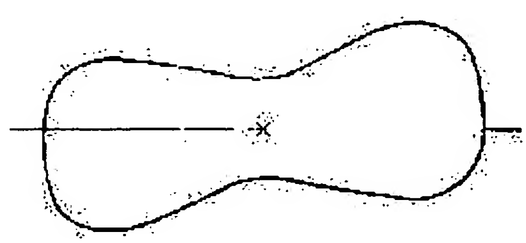
## (54) MAGNETORESISTIVE EFFECT ELEMENT AND ITS MANUFACTURING METHOD, MAGNETIC RANDOM ACCESS MEMORY, PORTABLE TERMINAL APPARATUS, MAGNETIC HEAD, AND MAGNETIC REPRODUCTION APPARATUS

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a magnetoresistive effect element that is magnetically stabilized, and has a reduced switching magnetic field, and to provide a method for manufacturing a magnetoresistive effect element.



SOLUTION: The width of an element end section is widened as compared with a center section, and is set to a shape that is asymmetrical to the axis of easy magnetization and at the same time is nearly rotary-symmetrical when a film surface vertical direction is used as an axis. The S-shaped structure of a magnetic domain is stabilized, and the switching magnetic field is

reduced. Also, the overlap of linear pattern etching is used with EB drawing for obtaining the structure.

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## CLAIMS

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[Claim(s)]
[Claim 1] The 1st ferromagnetic layer and the insulator layer formed on this 1st ferromagnetic layer, It has the 2nd ferromagnetic layer formed on this insulator layer. Said insulator layer is tunneled. Between said 1st ferromagnetic layer and the 2nd ferromagnetic layer The magneto-resistive effect component to which it is the magneto-resistive effect component which detects the electrical potential difference which tunnel current flows and is produced between the tunnel current or said 1st, and 2nd ferromagnetic layers, and the flat-surface configuration is characterized by the width of face of an edge being larger than the width of face of a central part.
[Claim 2] The magneto-resistive effect component according to claim 1 characterized by at least one side of said 1st and 2nd ferromagnetic layers containing the 3rd ferromagnetic layer, the non-magnetic layer formed on this 3rd ferromagnetic layer, and the 4th ferromagnetic layer formed on this non-magnetic layer.
[Claim 3] The 1st ferromagnetic layer and the 1st insulator layer formed on this 1st ferromagnetic layer, The 2nd ferromagnetic layer formed on this 1st insulator layer, and the 2nd insulator layer formed on this 2nd ferromagnetic layer, The magneto-resistive effect component to which it is the magneto-resistive effect component which has the 3rd ferromagnetic layer formed on this 2nd insulator layer, and that flat-surface configuration is characterized by the width of face of an edge being larger than the width of face of a central part.
[Claim 4] The magneto-resistive effect component according to claim 3 characterized by at least one layer of the said 1st, 2nd, and 3rd ferromagnetic layer containing the 4th ferromagnetic layer, the non-magnetic layer formed on this 4th ferromagnetic layer, and the 5th ferromagnetic layer formed on this non-magnetic layer.
[Claim 5] The magneto-resistive effect component according to claim 1 to 4 to which said flat-surface configuration is characterized by being unsymmetrical and being the symmetry of revolution mostly centering on a film surface perpendicular direction to an easy axis.
[Claim 6] Magnetic random access memory characterized by having the magneto-resistive effect component according to claim 1 to 5 connected between said bit lines and word lines on each intersection of two or more word lines, two or more bit lines which intersect two or more of these word lines, and said two or more word lines and two or more bit lines.
[Claim 7] Personal digital assistant equipment characterized by carrying magnetic random access memory according to claim 6.
[Claim 8] The magnetic head characterized by equipping the magnetic detection section with a magneto-resistive effect component according to claim 1 to 5.
[Claim 9] Magnetic-reproducing equipment characterized by carrying the magnetic head which equipped the magnetic detection section with the magneto-resistive effect component according to claim 1 to 5.
[Claim 10] the line which forms the junction field which consists of a layered product of a ferromagnetic / insulator / ferromagnetic at least, and crosses this junction field -- the manufacture

approach of the magneto-resistive effect component which etches said junction field using the mask of a pattern, changes a location, carries out multiple-times operation of this mask etching, and is characterized by to process said junction field into a predetermined configuration.
[Claim 11] The manufacture approach of the magneto-resistive effect component according to claim 10 characterized by adding processing by the electron beam further to the corner of said predetermined configuration.

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[Translation done.]

* NOTICES *



## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a magneto-resistive effect component, its manufacture approach, magnetic random access memory, personal digital assistant equipment, the magnetic head, and magnetic-reproducing equipment.
[0002]
[Description of the Prior Art] Although the thing of TAIBU with more various solid-state MAG memory than before is proposed, the proposal of the magnetic random access memory (MRAM) using the magnetic cell which shows giant magneto-resistance in recent years is performed, and attentions have gathered for the magneto-resistive effect component (TMR component) using the ferromagnetic tunnel junction especially as magnetic memory.
[0003] A ferromagnetic tunnel junction mainly consists of three layer membranes of the 1/insulating layer of ferromagnetic layers / ferromagnetic layer 2, an insulating layer is tunneled, and a current flows. In this case, junction resistance changes in proportion to the cosine of the ferromagnetic layer 1 and the angular relation of magnetization of two. Therefore, resistance takes the minimal value, when magnetization of the ferromagnetic layers 1 and 2 is parallel, and it takes the maximal value at the time of anti-parallel. This is called the tunnel magnetic-reluctance (TMR) effectiveness. For example, it is reported by the latest reference (Appl.Phys.Lett.77, 283 (2000)) that the change in resistance by the TMR effectiveness also becomes 49.7% in a room temperature.
[0004] In the magnetic memory apparatus which contains a ferromagnetic tunnel junction as a memory cell, one magnetization of a ferromagnetic layer is fixed, consider as a typical floor, and let other ferromagnetic layers be storage layers. In this cel, information is memorized because arrangement of magnetization of a typical floor and a storage layer matches binary information "0" and "1" to parallel or anti-parallel. It writes in and the writing of recording information reverses magnetization of a storage layer by the magnetic field which was independently prepared to this cel and which passes a current to wiring and is generated in it. Moreover, read-out is performed to a ferromagnetic tunnel junction by detecting a resistance change according a current to a sink and the TMR effectiveness. A magnetic memory apparatus consists of arranging a majority of such memory cells.
[0005] A switching transistor is arranged to each cel like DRAM, and a circumference circuit is incorporated and it is constituted by the actual configuration so that the memory cell of arbitration can be chosen. Moreover, the method which includes a ferromagnetic tunnel junction in the location where a word line and a bit line cross in accordance with diode is also proposed (refer to U.S. Pat. No. 5,640,343 and No. 5,650,958).
[0006] Now, considering high integration of the magnetic memory apparatus using a ferromagnetic tunnel junction as a memory cell, the magnitude of a memory cell becomes small and the magnitude of the ferromagnetic which constitutes a cel also becomes small inevitably. Generally, if a ferromagnetic becomes small, the coercive force will become large.
[0007] Since the magnitude of coercive force serves as a standard of the magnitude of a switching

magnetic field required in order to reverse magnetization, this means increase of a switching magnetic field. Therefore, in case information is written in, a bigger current is written in, it must stop having to pass to wiring, and the result of the increment in power consumption which is not desirable is brought about. Therefore, it is an important technical problem in utilization of high integration MAG memory to reduce the coercive force of the ferromagnetic used for the memory cell of magnetic memory.
[0008] Moreover, when using as a memory cell of magnetic memory, generally using the ferromagnetic with which the flat-surface configuration carried out the rectangle is considered. However, it is known that the special magnetic domain called an edge domain to an edge will arise in the case of a rectangular minute ferromagnetic (for example, J.App.Phys.81 and 5471 (1997) reference). This is for forming the pattern which it rotates to a whirl as magnetization meets the side, in order to reduce demagnetizing field energy in a rectangular shorter side. An example of such magnetic structure is shown in drawing 45 , and although magnetization arises in the direction which followed the magnetic anisotropy in the central part of a magnetization field, in both ends, magnetization arises in the different direction from a central part.
[0009] If flux reversal is considered to the ferromagnetic of this rectangle, going on so that an edge domain may grow and that field may be enlarged is known. Here, considering the edge domain of rectangular both ends, the case ( drawing 45 (a), smooth S form structure) where it is mutually suitable in parallel, and the anti-parallel direction may be turned to ( drawing 45 (b) C mold structure). . to which coercive force becomes large since a magnetic domain wall is formed 360 degrees when having turned to the anti-parallel direction -- in order to solve this technical problem, using the ferromagnetic of an ellipse form as a storage layer is proposed (refer to [ 5,757,695th ] United States patent). This presses down generating of the edge domain which an edge domain produces at the edge in the case of a rectangle etc. to the configuration of a ferromagnetic using the property to be very sensitive, by realizing a single domain, is the thing it enabled it to reverse uniformly over the whole ferromagnetic, and can make a reversal magnetic field small.
[0010] Moreover, using the ferromagnetic of the configuration which has the include angle which is not right-angled in the corner is proposed like a parallelogram as a storage layer (refer to JP,11-273337,A). In this case, about 1 appearance can be made to reverse magnetization, although an edge domain exists, without the case of a rectangle not occupying a big field but generating the still more complicated minute domain in process of flux reversal. Reduction of a reversal magnetic field is achieved as the result.
[0011] moreover, on the other hand, although a configuration is still a rectangle, boiling and using a thing including antiferromagnetism association between the above-mentioned ferromagnetic layers in the multilayers which consist of a non-magnetic layer which intervenes among them including at least two ferromagnetic layers is proposed (refer to [ 5,953,248th ] JP,9-25162,A, Japanese Patent Application No. 11-263741, and an United States patent).
[0012] In this case, that magnetic moment or thickness is different, and, as for two ferromagnetic layers, magnetization has turned to hard flow by antiferromagnetism-association. For this reason, it is possible that it is equivalent to the ferromagnetic with which magnetization had the small magnetization corresponding to the difference or thickness difference of the magnetic moment in the direction of an easy axis as phase murder and the whole storage layer mutually effectually. If a magnetic field is impressed to the sense and reverse sense of small magnetization of the direction of an easy axis of 100 million layers of this account which it has, magnetization of each ferromagnetic layer will be reversed with antiferromagnetism association maintained. With this structure, since line of magnetic force has closed, the effect of demagnetizing field is small, and since the switching magnetic field of a recording layer is decided by the coercive force difference of each ferromagnetic layer, magnetic reversal becomes possible by small switching ****.
[0013] By the way, in the TMR component of MRAM application, submicron component size is called for from the demand to high integration. Then, the production process is briefly explained using the sectional view (left-hand side) and plan (right-hand side) of drawing 46 about the example (W.J.Gal lagher et al., J.Appl.Phys.81, 3741 (1997) reference) which produces the TMR component of

submicron size using electron beam (EB) drawing. As first shown in drawing 46 (a), the multilayer structure containing the three-tiered structure of the lower electrode 462 which mainly consists of a magnetic metal, aluminum oxide barrier 463, and the up electrode 464 which mainly consists of a magnetic metal is deposited with magnetron sputtering equipment on the Si substrate 461, and a lower electrode is formed by etching the multilayer structure using a photoresist and ion milling (here, near [ of a lower electrode / some ] a joint are shown). Next, as shown in drawing 46 (b), by EB drawing, the pattern of the EB resist 456 of a negative mold is formed in a part for a joint, 2nd ion milling is performed using it and the pattern of the joint of submicron size is formed. It controls by this ion milling so that it runs through the oxide barrier 463 and etching stops at the upper part of the lower electrode 462.

[0014] Next, it is SiO2, leaving the EB resist 465 to a joint, as shown in drawing 46 (c). An insulator layer 466 is deposited with magnetron sputtering equipment. It is SiO2 as finally shown in drawing 46 (d). According to the lift-off process using EB resist under an insulator layer, a contact hole is exposed in self align on a joint, the up wiring 467 of Ag/Au is produced by patterning using the lift off of a photoresist after that, and contact is formed in an up electrode.

[0015] Some troubles in order to perform direct EB drawing on the multilayer structure which has the basic structure of a ferromagnetic metal / oxide ****** / ferromagnetic metal although the TMR component with submicron junction size is obtained by the self align manufacture approach of a TMR component using this EB drawing are ******.

[0016] It has the backscattering of the electron ray by the metal stronger than a half-**** ingredient in EB drawing process to the multilayer structure which contains a magnetic metal although regist patterning of the submicron size to the joint by EB drawing is performed in drawing 46 (b), the so-called proximity effect in which the drawing pattern obtained as the result spreads greatly will become remarkable, and the detailed nature and the controllability of a drawing pattern configuration will be lost. As shown in drawing 46 (b) as the result, also when a rectangle is drawn as a configuration of a joint, the configuration actually acquired will turn into a configuration in which the acute nature of a corner was lost remarkably.

[0017] Here, close relation is between the holding power (Hc) which is the flat-surface configuration and magnetic property of the joint of a TMR component, and it has become clear that holding power becomes large rather than a rectangle with the strong acute nature of an angle at about 2 times in the rectangle with which the angle was round. Consequently, there was a problem that a TMR component with a low holding power property important for actuation of MRAM was no longer obtained. .

[0018]

[Problem(s) to be Solved by the Invention] As mentioned above, reduction of the magnetic field (switching magnetic field) which reverses magnetization of a recording layer is an indispensable element in magnetic memory, and using some configurations and multilayers including antiferromagnetism association is proposed.

[0019] However, in the minute ferromagnetic placed into a magnetic small memory cell which is used for high integration MAG memory, if the width of face of the minor axis becomes below submicron extent from several microns, for example, it is known that different magnetic structure (edge domain) from the magnetic structure of the central part of the magnetic substance will arise under the effect of demagnetizing field in the edge of a magnetization field.

[0020] In the minute magnetic substance which is used for the cel of high integration MAG memory, about the effect of the edge domain produced at the edge as mentioned above, it is large and change of the magnetic structure pattern in flux reversal becomes complicated. As a result, coercive force becomes large, and a switching magnetic field increases.

[0021] It considers fixing an edge domain by making for change of such complicated magnetic structure to arise into the approach of preventing as much as possible (refer to United States patent 5,748,524th and JP,2000-100153,A).

[0022] Although the behavior in the case of flux reversal is controllable by this, reduction of a switching magnetic field cannot be aimed at substantially. Moreover, since an edge domain is fixed, it is necessary

to add another structure, and it is not suitable for densification.
[0023] As mentioned above, in order to produce the TMR component which has junction of submicron ferromagnetic / insulator / ferromagnetic, EB drawing process was used, but in EB **** to a metal multilayer-structure top, the detailed pattern formation in which the proximity effect carried out configuration control remarkably, or since it was difficult, there was a problem that it became difficult to obtain the TMR component of a low holding power property. In the lithography process, near the limitation of resolution, this essentially originates in the problem also common to a photolithography that the acute nature of the corner is lost remarkably, when a rectangle configuration is formed.
[0024] Without newly adding structure, in case the 1st purpose of this invention writes ** Li in offering the cel which has stable magnetic structure in extent in which the above high density integration is possible in a minute magnetic memory cell and writes information in a cel at coincidence, it is to reduce a required switching magnetic field. Furthermore, it is magnetically stable, and the magnetic memory cell by which the switching magnetic field was reduced enough is constituted, and it is in offering the non-destroying MAG memory using such a magnetic memory cell in which random access is possible.
[0025] The 2nd purpose of this invention is to offer the easy and suitable good manufacture approach of productivity for the magneto-resistive effect component of this invention.
[0026]
[Means for Solving the Problem] In order that this invention may solve the above-mentioned technical problem, the 1st magneto-resistive effect component of this invention The 1st ferromagnetic layer and the insulator layer formed on this 1st ferromagnetic layer, It has the 2nd ferromagnetic layer formed on this insulator layer. Said insulator layer is tunneled. Between said 1st ferromagnetic layer and the 2nd ferromagnetic layer It is the magneto-resistive effect component which detects the electrical potential difference which tunnel current flows and is produced between the tunnel current or said 1st, and 2nd ferromagnetic layers, and the flat-surface configuration is characterized by the width of face of an edge being larger than the width of face of a central part.
[0027] Moreover, the 1st insulator layer by which the 2nd magneto-resistive effect component of this invention was formed on the 1st ferromagnetic layer and this 1st ferromagnetic layer, The 2nd ferromagnetic layer formed on this 1st insulator layer, and the 2nd insulator layer formed on this 2nd ferromagnetic layer, It is the magneto-resistive effect component which has the 3rd ferromagnetic layer formed on this 2nd insulator layer, and that flat-surface configuration is characterized by the width of face of an edge being larger than the width of face of a central part.
[0028] That is, in this invention, reduction of a switching magnetic field is aimed at by controlling the magnetic structure, without using magnetic structure peculiar to a minute ferromagnetic, and giving another structure in the magneto-resistive effect component containing the ferromagnetic layer used as a magnetic memory cell.
[0029] For this reason, characteristic magnetic structure, especially an edge domain are controlled, and in order to reduce a switching magnetic field, a suitable component configuration is used. Unlike the conventional technique, this component configuration is not reducing the field of an edge domain like a parallelogram, and gives the field of a certain magnitude rather. Moreover, it is made to act as a nucleus of flux reversal, without fixing an edge domain, applying a bias magnetic field to an edge.
[0030] In order to perform this, the large width of face of a component edge is taken as compared with a central part, the smooth S form structure of a magnetic domain is stabilized, and a switching magnetic field is reduced as the result. Reduction of a switching magnetic field can be ensured by furthermore considering as a configuration almost symmetrical with rotation centering on asymmetry and a film surface perpendicular direction about an easy axis. It seems that this configuration is shown in drawing 1 . As for an easy axis and x marks, the straight line in drawing shows the location of a symmetry axis of rotation inversion.
[0031] moreover, the line which the manufacture approach of the magneto-resistive effect component of this invention forms the junction field which consists of a layered product of a ferromagnetic / insulator / ferromagnetic at least, and crosses this junction field -- said junction field is etched using the mask of a pattern, a location is changed, multiple-times operation of this mask etching is carried out, and it is

characterized by processing said junction field into a predetermined configuration.
[0032] the line which plurality intersected in the fine structure in connection with the joint of a TMR component in this invention -- it produces by the approach of pattern formation. This mainly solves the above-mentioned trouble by the marginal performance of lithography. that is, this crossing line -- the joint production process by the pattern -- a line with detailed drawing nature and a controllability high in lithography -- since pattern formation by the pattern is performed, also in a detailed rectangle configuration, it is rare to lose the acute nature of a corner, and it can perform good patterning of a configuration controllability. The highly efficient TMR component which has the submicron fine structure which can be integrated highly as the result is producible by the easy and high yield.
[0033]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to a drawing.
[0034] (1st operation gestalt) The 1st operation gestalt explains the fundamental configuration of this invention using an example as a result of computer simulation. Drawing 2 is the top view of the magnetic-substance film concerning the 1st operation gestalt of this invention. The magnetic-substance film of the 1st operation gestalt has a S character-like hook type, and width of face differs at the central part and edge of a component. That is, 0.4 micrometers and the thickness of 0.15 micrometers and die length are [ in / on a central part and / in the ferromagnetic film / width of face of 0.1 micrometers, and an edge ] 1.5nm.
[0035] Although the configuration of drawing 2 is a polygon in which each top-most vertices have the include angle which is 90 degrees, it does not limit to this and especially each top-most vertices are not limited to 90 degrees. Moreover, each side does not need to be a straight line, either and, generally may consist of curves.
[0036] moreover -- although it is not what also limits component size above -- the maximum width -- about [ 1micrometer ] ** Li -- a small thing is desirable and 10 times of die length are desirable from 1 time of the maximum width. The thickness of a ferromagnetic has good 10nm or less, and its 5nm or less is more desirable. For high integration, the small thing of especially component size is desirable.
[0037] As an ingredient used for a ferromagnetic layer, although Co9 Fe is used in this simulation, a magnetic material is good at magnetic materials usually used, such as Fe, Co, nickel, and those cascade screens, an alloy. Moreover, Cu, Au, Ru, aluminum, etc. may be the cascade screens containing the layer which consists of a metal non-magnetic material.
[0038] About the hysteresis of this system, what was obtained as a result of simulation is shown in drawing 3 . From drawing 3 , coercive force Hc is searched for with 242 oersteds (Oe). Moreover, drawing 3 shows that the difference of the switching magnetic field Hsw and coercive force Hc is not so large in the magneto-resistive effect component of this invention. That is, in a flux reversal process, the minute magnetic domain means having not generated in a complicated form.
[0039] Change of the pattern of the magnetic domain in the 1st operation gestalt is shown in drawing 4 . Drawing 4 showed the situation of change of the magnetic domain structure when changing H from a +1000 oersted external magnetic field to -1000 oersted as sense of plus of the left.
[0040] When an external magnetic field is H= +300 oersted, (b) and the magnetization direction of an edge begin to change the sense from an easy axis, and take and stabilize (c) and the magnetic domain structure of a smooth S form at the time of H= 0 oersted. Furthermore, when an external magnetic field becomes large to a negative direction, it turns out that the magnetization direction is rotating greatly in (d) and a part with the wide width of face of an edge. If an external magnetic field furthermore becomes large negative, it will become (e) and the magnetic domain structure reversed completely.
[0041] domain Wall which an edge domain is expanded at the time of magnetic reversal, and is between an edge domain and the magnetic domain of a center section moves in the direction of a component center -- magnetization -- being reversed -- complicated domain structure appears to no values at the time of Li and an external magnetic field sweep. Therefore, while reversal becomes possible in a small magnetic field, a thing also with a small switching magnetic field required in order to reverse magnetization completely is realizable.

[0042] In addition, by this system, the rate of the residual magnetization to saturation magnetization is 0.86. This is because the edge domain exists. Generally, there are a gap and a disordered part in the magnetization direction of a ferromagnetic, and when the rate of the residual magnetization to saturation magnetization is smaller than 1, in the ferromagnetic tunnel junction using the ferromagnetic, a tunnel magnetic-reluctance ratio (MR ratio) decreases compared with the case where there is neither a gap nor turbulence. However, by this system, since up-and-down ferromagnetic layers including an insulating layer are the same configurations, the up-and-down ferromagnetic layer has the almost same magnetic domain structure. Therefore, although the rate of the residual magnetization to saturation magnetization is smaller than 1, there is almost no reduction of the tunnel magnetic reluctance of the magnetization direction.
[0043] In order to show that this invention is effective, a thing [ / coercive force ] is shown in drawing 5 about some configurations. In this drawing, thickness of 2.0nm, die length of 0.4 micrometers, and central width of face are set to 0.1 micrometers, and the width of face of the edge in a configuration (f) and (g) shows the result of having performed simulation as 0.15 micrometers.
[0044] In drawing 5 , the thing of the configuration which cut off two top-most vertices like a configuration (b) where a rectangle faces depends that coercive force is low on the same reason as the case of the above-mentioned parallelogram. However, it turns out that it is the thing of the configuration in drawing which is the configuration of this invention (g) that coercive force becomes small most.
[0045] Moreover, the magnetic domain structure in the case of the parallelogram which is one of the another examples of a comparison is shown in drawing 6 . As shown in drawing, it is the configuration which decreases an edge domain in this case toward the direction where magnetization differs from an easy axis only in few fields which met the oblique side.
[0046] On the other hand, in this invention, magnetization is distributed like drawing 2 , and the field of an edge domain is extended by it. In the case of the example of a comparison of above-mentioned drawing 6 , coercive force serves as 249 oersteds, and in the case of this invention shown in drawing 2 , it is small although it is [ some ] compared with this.
[0047] (2nd operation gestalt) Drawing 7 is the top view of the magneto-resistive effect component concerning the 2nd operation gestalt of this invention. Although the width of face of a broad component edge was fixed with the 1st operation gestalt, the width of face of a component edge is changing in the broad department with the 2nd operation gestalt. It turns out for this configuration that the direction of magnetization is carrying out sequential change in the broad part.
[0048] As an ingredient used for a ferromagnetic layer, like [ this simulation ] the 1st operation gestalt, although Co9 Fe is used, a magnetic material is good at magnetic materials usually used, such as Fe, Co, nickel, and those cascade screens, an alloy. Moreover, Cu, Au, Ru, aluminum, etc. may be the cascade screens containing the layer which consists of a metal non-magnetic material.
[0049] The magnetization curve in the 2nd operation gestalt is shown in drawing 8 . Drawing 8 shows that coercive force Hc becomes very low with 148 oersteds (Oe), and the rate of the residual magnetization to saturation magnetization is further kept high with 0.96.
[0050] (3rd operation gestalt) With the 1st and 2nd operation gestalten, although only the monolayer of a ferromagnetic was described, also when the cascade screen which consists of at least one-layer the insulating layer or non-magnetic metal layer which intervenes a two-layer ferromagnetic and between them at least is included, the same result is obtained.
[0051] Drawing 9 (a) is the sectional view of the ferromagnetic single tunnel junction structure where the laminating of the ferromagnetic layer 1 and the ferromagnetic layer 3 was carried out through the insulating layer 2. The small magneto-resistive effect component 10 of holding power can be obtained also to this laminated structure by giving the flat-surface configuration of the 1st or 2nd operation gestalt.
[0052] In this case, you may make it the so-called spin bulb mold which carried out antiferromagnetism layer grant on one outside of the ferromagnetic layers 1 or 3. Drawing 9 (b) makes the ferromagnetic layer 1 of drawing 9 (a) 3 layer structures to which the laminating of the ferromagnetic layer 1-1 and the ferromagnetic layer 1-2 was carried out through the non-magnetic layer 6. These 3 layer structures may

permute the part of the ferromagnetic layer 3. Furthermore, it can also permute by the multilayers to which the laminating of a ferromagnetic layer and the non-magnetic layer was carried out repeatedly.
[0053] As for drawing 10 , the laminating of the ferromagnetic layer 11 and the ferromagnetic layer 13 is carried out through an insulating layer 12, and the ferromagnetic layer 13 is the sectional view of ferromagnetic duplex tunnel junction structure joined through the ferromagnetic layer 15 and the insulating layer 14 further. The small magneto-resistive effect component 20 of holding power can be obtained also to this laminated structure by giving the flat-surface configuration of the 1st or 2nd operation gestalt. In this case, you may make it the so-called spin bulb mold which gave the antiferromagnetism layer to the outside of the ferromagnetic layers 1 and 3.
[0054] Drawing 11 makes the ferromagnetic layer 11 of drawing 10 the three-tiered structure to which the laminating of the ferromagnetic layer 11-1 and the ferromagnetic layer 11-2 was carried out through the non-magnetic layer 16. This three-tiered structure forms an antiferromagnetism joint recording layer through a non-magnetic layer 16. This three-tiered structure may permute the part of the ferromagnetic layer 15, and can apply it to at least one layer of the ferromagnetic layers 11 and 15.
[0055] The small magneto-resistive effect component 30 of holding power can be obtained also to this laminated structure by giving the flat-surface configuration of the 1st or 2nd operation gestalt.
[0056] Drawing 12 makes the ferromagnetic layer 13 of drawing 10 the three-tiered structure to which the laminating of the ferromagnetic layer 13-1 and the ferromagnetic layer 13-2 was carried out through the non-magnetic layer 17. The small magneto-resistive effect component 40 of holding power can be obtained also to this laminated structure by giving the flat-surface configuration of the 1st or 2nd operation gestalt.
[0057] In addition, at least one layer of the ferromagnetic layers 11 and 15 can also be made into the three-tiered structure of a ferromagnetic layer / non-magnetic layer / ferromagnetic layer to the configuration of drawing 12 . moreover, the configuration of drawing 11 -- receiving -- further -- the count laminating of a request of an insulating layer and a ferromagnetic layer -- you may carry out.
[0058] It turns out that drawing 13 compares the value of the holding power Hc at the time of changing a flat-surface configuration about the three-tiered structure of Co9 Fe/Ru/Co9 Fe, and coercive force can decrease [ configuration / of this invention / (d) . (e) ] greatly compared with the thing of the usual rectangle.
[0059] In the 3rd operation gestalt, a magnetic material, a barrier layer ingredient, etc. can be chosen as follows. Especially a limit does not have the element of the ferromagnetic layer of this invention, and a class, and magnetic semiconductors, such as Heusler alloys, such as other NiMnSb(s) of oxides, such as Fe, Co, nickel or these alloys, magnetite with the large rate of spin polarization, CrO2, and RXMnO3-y (R: rare earth, X:calcium, Ba, Sr), and PtMnSb, Zn-Mn-O, Ti-Mn-O, CdMnP2, and ZnMnP2, can be used for them.
[0060] The thickness of extent which does not become superparamagnetism is required for the thickness of the ferromagnetic layer of this invention, and it is desirable that it is 0.4nm or more. Moreover, since a switching magnetic field will become large if not much thick, it is desirable that it is by 2.5nm or less. Moreover, it is good unless ferromagnetism is lost, even if nonmagnetic elements, such as Ag, Cu, Au, aluminum, Mg, Si, Bi, Ta, B, C, O, N, Pd, Pt, Zr, Ir, W, Mo, and Nb, are somewhat contained in these magnetic substance.
[0061] Fe-Mn, Pt-Mn, Pt-Cr-Mn, nickel-Mn, Ir-Mn, NiO, etc. can be used for the antiferromagnetism film. As a non-magnetic layer, Cu, Au, Ru, Ir, Rh, Ag, etc. can be used. When using as antiferromagnetism association (in the case of a pin layer), Ru, Ir, and Rh are desirable, when using as ferromagnetic association (in the case of a recording layer), Cu, Au, and Ag are desirable, but since adjustment is also possible, it is not restricted to these by thickness etc.
[0062] As the dielectric or insulating layer of this invention, various dielectrics, such as aluminum 2O3, SiO2, MgO and AlN, AlON, GaO and Bi 2O3, and SrTiO2, AlLaO3, can be used. As for these, oxygen and a nitrogen deficit may exist.
[0063] As for dielectric layer thickness, it is desirable that it is 3nm or less depending on the plane-of-composition product of TMR. There is no substrate and it can produce especially a limit on [, such as Si,

$SiO_2$, aluminum2O3, and AlN, / various ] a substrate. It is desirable to use cascade screens, such as monolayers, such as Ta, Ti, Pt, Pd, and Au, and Ti/Pt, Ta/Pt, Ti/Pd, Ta/Pd, as a substrate layer and a protective layer moreover.

[0064] Next, the manufacture approach for producing the magneto-resistive effect component stated with the above-mentioned 1st thru/or the 3rd operation gestalt is described. After such component formation generally applies a resist after film formation, forming and developing a pattern using either light, an electron beam and an X-ray, forming a resist pattern, performing ion milling or etching by making this into a mask and forming a pattern, it is carried out through the process of exfoliating a resist.

[0065] In producing comparatively big size, for example, the magneto-resistive effect component of micron order, it forms the pattern of the magneto-resistive effect component in this invention as produced hard surface mask blanks, such as silicon oxide and silicon nitride, after a spatter and shown in drawing 2 or drawing 7 by reactive ion etching (RIE) in the TMR film. A magneto-resistive effect component is producible by carrying out ion milling of this sample.

[0066] Optical lithography can be used in smaller magneto-resistive effect component, for example, about 2-3 to about 0.1 micrometers submicron size, component production. In this case, the hard surface mask blank which has the configuration pattern of the magneto-resistive effect component in this invention beforehand is produced, and it can produce by carrying out pattern formation.

[0067] Electron beam exposure can be used about still smaller size, for example, component production of about 0.5 micrometers or less. However, since the component itself is small in this case, the configuration part for extending the edge domain field in this invention becomes still smaller, and production becomes very difficult.

[0068] In order to produce the component of the above small sizes, the proximity effect correction of an electron beam can also be used. Usually, proximity effect correction amends the proximity effect within a graphic form produced by the backscattering from the substrate of an electron beam, and it is used in order to form a right pattern. For example, when forming a rectangular pattern, near top-most vertices, the amounts of stored charge run short and the phenomenon in which rectangular top-most vertices become round is seen. In order to clarify top-most vertices, in the case of a component about 0.5 micrometers or less, a normal pattern can be especially obtained near top-most vertices and by driving an amending point beam into the outside of a graphic form, and increasing the amount of stored charge. The configuration of this invention where applied this approach and the width of face of a component edge spread can be formed.

[0069] For example, when forming drawing 2 R> 2 of the 1st or 2nd operation gestalt, or the configuration of drawing 7 , formation of the configuration where the width of face of an edge is wide is attained by using a rectangle as a basic pattern and driving in an amending point beam near 2 top-most vertices which face, respectively.

[0070] At this time, more than it makes [ many ] the amount of charges driven in compared with the case of the usual proximity effect correction, it adjusts the placing location of an amending point beam suitably or it recovers top-most vertices using those both, a configuration can be amended. By making it such, it becomes possible to form the configuration of this invention. Furthermore, in order to form the component configuration of drawing 2 , for example, it is also possible to irradiate the amending point beam of two or more points.

[0071] As mentioned above, although a rectangular component can be formed by striking the amendment beam after formation in order to realize the configuration of this invention with a rectangular broad edge, it is necessary to realize a submicron detailed rectangle configuration on the preceding paragraph story. With the conventional technique, when it was going to realize such a configuration, there was a problem to which a corner becomes round. The 4th thru/or 6th operation gestalt explains the operation gestalt which solves such a problem.

[0072] (4th operation gestalt) Drawing 14 shows the main point of the manufacture approach of this invention by the mimetic diagram. As mentioned above, in a photolithography, when a rectangle configuration is formed with the usual lithography, if set to about 0.2 micrometers or less also with

about 0.5 micrometers or less and EB lithography, radicalization of the angle of a rectangle configuration will be lost remarkably. As a cure on this problem, by the photolithography, although the proximity effect correction to reflection of light and proximity effect correction [ as opposed to an electronic backscattering with EB lithography ] are considered, there is a problem that actuation of amendment takes time amount, and effectiveness sufficient in 0.1-micrometer size cannot be raised.
[0073] a line [ in / to it / lithography ] -- the width-of-face controllability of a pattern is very good, and if photolithographies are also width of face of 0.2 micrometers or less, and EB lithography, width of face of 0.1 micrometers or less can be specified correctly. in order to form the target rectangle pattern 51 (slash section) as shown in drawing 14 if this fact is applied -- first -- the 1st line -- a pattern 52 is formed with lithography and the other field as a mask layer is removed by dry etching. then, the 2nd line -- a pattern 53 -- the 1st line -- it forms with lithography, and it considers as a mask and dry etching removal of the field besides the rectangle which remained is carried out so that it may intersect perpendicularly with a pattern. Thereby, a pattern very acute as a corner 54 of a rectangle pattern can be formed.
[0074] It can deform and apply to various forms so that it may state to the following operation gestalten on the basis of the approach of drawing 14 .
[0075] first -- as the 4th operation gestalt -- a line -- the approach formed maintaining the acute nature of a corner for the joint configuration of a TMR component by repeating pattern formation and dry etching twice is explained.
[0076] Drawing 15 thru/or drawing 26 explain the production process of a TMR component that the acute nature of the above corners was maintained, and shows the sectional view (the A-A' line in a plan was met) near the core of a joint to right-hand side (b) on a plan and left-hand side (a) for every process.
[0077] First, as shown in drawing 15 , the lower wiring layer 62 of Ta, the magnetic tunnel junction (MTJ) layer 63 which consists of the ferromagnetic / an insulator / ferromagnetic structure containing the multilayers of a magnetic metal, and the contact layer 64 of Ta are continuously deposited all over the substrate 61 top which consists of Si. The field which serves as the TMR component (joint) 65 behind is shown in the plan with the broken line.
[0078] Next, it is Cl2, using a resist (un-illustrating) as a mask, after forming the pattern of lower wiring by the photolithography, as shown in drawing 16 . A lower circuit pattern is etched to a substrate side using the reactant dry etching by the mixed gas of Ar.
[0079] Next, it is SiOx about the whole pattern which carried out dry etching as shown in drawing 17 . It embeds by the insulating layer 66, and flattening is performed until the contact layer of Ta is exposed with the process of CMP or etchback.
[0080] next, the 1st line for forming a joint, as shown in drawing 18 -- it forms by the resist 67 so that it may migrate to the range longer than the die length of the joint aiming at a pattern. this time -- the 1st line -- what is necessary is to be able to form with a sufficient controllability easily by the photolithography, if it becomes to about 0.1 micrometers, and just to form with EB lithography, when it is less than [ it ] although the width of face of a pattern serves as the lower limit of this TMR component

[0081] next, it is shown in drawing 19 -- as -- the line of a resist 67 -- a pattern is imprinted in the contact layer 64 of Ta, and a resist 67 is exfoliated after that. this time -- as the reactant gas of F system -- for example, SF6 the line by the resist 67 when it uses and reactant dry etching is performed -- a pattern can be correctly imprinted to the contact layer 64 and the SiOx insulating layer 66 of Ta. since [ moreover, ] the magnetic metal of the MTJ layer 63 is tolerant to the dry etching of F system gas -- the contact layer 64 of Ta -- a line -- it can form in a pattern.
[0082] Next, as shown in drawing 20 , ion milling of the MTJ layer 63 of a substrate is carried out by using the contact layer 64 of Ta as a mask. the case where it carries out here until the lower wiring layer 62 of Ta exposed beam energy 400eV Ar ion milling since Ta has resistance sufficient as a hard surface mask blank to ion milling -- retreat of a mask, and reduction of thickness -- few -- the line of Ta -- a pattern 64 can be imprinted in the MTJ layer 63 good.
[0083] It replaces with etching of the above-mentioned MTJ layer 63 at ion milling, and is Cl2. The

reactant dry etching by the mixed gas of Ar may be used. In this case, as a mask layer, it is diamond rye carbon (DLC), AlOx, and SiO2. The thing excellent in Cl system etching resistance, such as a multilayer-resist mask, is used. It is desirable to use things which weakened Cl system etching resistance a little, such as TEOS, for the insulator layer 66 (66') etched into coincidence. Moreover, it is necessary to form a mask layer beforehand on the contact layer 64 in this case.
[0084] Next, as shown in drawing 21 , it embeds by insulating-layer 66' of SiOX again, flattening is performed, and the contact layer 64 of Ta is exposed. then, other two sides in which the joint remained as shown in drawing 22 -- specifying -- and a joint -- receiving -- the 2nd line long enough -- the resist 68 which has a pattern is formed by the photolithography.
[0085] next, the 2nd line according to a resist 68 as shown in drawing 23 -- a pattern is imprinted in the contact layer 64 of Ta of a substrate by dry etching using the reactant gas of F system.
[0086] next, the 2nd line formed in the contact layer 64 of Ta as shown in drawing 24 -- using a pattern as a hard surface mask blank, the MTJ layer 63 is etched until it reaches the lower wiring layer 62 of Ta by ion milling. Even at this process, the MTJ layer 63 is processed into the configuration of the final TMR component 65, and the rectangle configuration of that joint is formed, with the acute nature of a corner maintained.
[0087] although the 4th operation gestalt shows the case of a rectangle as a configuration of a joint -- the 2nd line -- a pattern -- the 1st line -- it is also possible to lean and form rather than to to make it intersect perpendicularly with a pattern, and the joint of the concurrency quadrilateral which has a low holding power property too in that case can be formed.
[0088] Next, as shown in drawing 25 , it is SiOx about the whole again. Flattening is embedded and carried out by the insulator layer, and the contact layer 64 of Ta is exposed. As finally shown in drawing 26 , after depositing on the whole surface the up wiring layer 69 which consists of Ti/TiN/AlCu/Ti, the TMR component 63 of the rectangle by which the corner was formed in the right angle is completed by performing patterning by the photolithography and dry etching.
[0089] moreover, the 2nd line after depositing on the whole surface previously the up wiring layer other than the process which forms the up wiring layer 69 after forming the joint 63 which was mentioned above as a process after drawing 2121 -- the process [ NINGU / a line / a joint / the whole up wiring / after that / forms a pattern and / process / PA evening 1 ] is also possible. In that case, there is an advantage that the lithography process for up wiring formation becomes unnecessary.
[0090] further -- again -- up wiring -- the 2nd line -- as BA evening 1 N formation, simultaneously the rectangle configuration suitable when carrying out for ** and MRAM -- the 2nd line -- since pattern width of face can form a broad thing, it can also form the width of face of up wiring which works as main wiring which impresses a current field to the joint of a TMR component in the broad condition in which high magnetic field impression is more possible
[0091] (5th operation gestalt) a degree -- as the 5th operation gestalt -- a line -- by repeating pattern formation and dry etching twice explains how to form the hard surface mask blank for etching the joint configuration of a TMR component, with the acute nature of a corner maintained.
[0092] A corner explains the production process of a TMR component with a detailed right angle, and drawing 27 thru/or drawing 38 show the sectional view (the A-A' line of a plan was met) near the core of a joint to right-hand side on a plan (b) and left-hand side for every process. Since the process from drawing 27 to drawing 29 can be made to be completely the same as that of the process from drawing 15 to drawing 17 , it omits the explanation which overlaps here. However, it is the field where the magnetic tunnel junction (MTJ) layer which 71 becomes from the ferromagnetic / insulator / ferromagnetic structure where the Si substrates 61 and 72 contain the lower wiring layer of Ta, and 73 contains the multilayers of a magnetic metal, and 74 become the contact layer of Ta behind, and 75 becomes a TMR component (joint).
[0093] Following on the process of drawing 29 , as shown in drawing 30 , the mask layer 77 of Cr used as the dry etching mask for specifying a joint is deposited on the whole front face which carried out flattening.
[0094] next, it is shown in drawing 31 -- as -- the 1st line -- the resist 78 which has a pattern is formed

by the photolithography. next, the 1st line according to a resist 78 as shown in drawing 32 -- a pattern -- Cl2 O2 It imprints in Cr mask layer of a substrate using the dry etching by mixed gas. At this time, even if that the mask layer of Cr is thin performs dry etching of Cr mask layer, they are Ta74 of a substrate, and SiOx. The surface smoothness of an insulator layer 76 is hardly affected.
[0095] next, it is shown in drawing 33 -- as -- the 2nd line -- the resist 79 which has a pattern -- the 1st line -- it forms by the photolithography so that it may intersect perpendicularly with a pattern (78).
[0096] next, it is shown in drawing 34 -- as -- the 2nd line of a resist 79 -- a pattern -- too -- Cl2 and O2 It imprints in Cr mask layer 77 of a substrate using the dry etching by mixed gas. in this way, 2 times of lines -- while the acute nature of a corner had been maintained as a configuration of the final joint 75, patterning of the Cr mask layer 77 is carried out by the process of pattern formation and dry etching.
[0097] Since the dry etching selection ratio of this Cr mask layer 77 and Ta contact layer 74 of a substrate can form the thickness of Cr mask layer 77 thinly with about 20nm according to a large thing here so that it may state below, the 1st line of drawing 32 R> 2 -- the 2nd lines [ without especially after the imprint of a pattern passing through the process of embedding and flattening ], such as drawing 33 or drawing 34 , -- formation and an imprint of a pattern can be performed, without spoiling the configuration of a joint.
[0098] Next, Cr mask layer 77 formed as a good rectangle pattern as shown in drawing 35 is used, and it is SF6. The contact layer 74 of Ta is etched by dry etching.
[0099] Next, it etches until the lower wiring layer 72 of Ta of a substrate exposes the MTJ layer 73 by Ar ion milling, using as a mask Ta contact layer 74 formed as a good rectangle pattern, as shown in drawing 36 .
[0100] Like [ etching of the MTJ layer 73 ] the 4th operation gestalt, it replaces with Ar ion milling and is Cl2. The reactant dry etching by the mixed gas of Ar may be used.
[0101] After that, like the 4th operation gestalt, as shown in drawing 37 , flattening of the whole is embedded and carried out by SiOx insulating-layer 76', as shown in drawing 38 , the up wiring 80 is formed and the formation process of the TMR component (joint) 75 is completed.
[0102] Here, as a mask layer for specifying a joint, it is also ****** to use nonphotosensitivity organic materials, such as DLC and polyimide. Since the dry etching which made O2 reactant gas can be used for the patterning when a mask layer is carried out and these ingredients are used and a very large selection ratio with the metal contact layer of a substrate can be taken, in case it is patterning of a mask layer, there is almost no fear of the surface smoothness of a substrate being spoiled. however -- in that case -- the beginning -- a line -- in the photolithography which specifies a pattern, O-proof2 plasma treatment or the multilayer-resist process on a front face of a resist called a silanizing process is required. Moreover, since DLC and a nonphotosensitivity organic material are amorphous, also when the minute pattern of 0.1-micrometer order is formed, they have the features that a very smooth side-attachment-wall configuration is acquired.
[0103] Also in the 5th operation gestalt, a corner can obtain the TMR component of the rectangle formed in the right angle.
[0104] (6th operation gestalt) a degree -- as the 6th operation gestalt -- a line -- by repeating pattern formation and dry etching 3 times explains how to form the joint configuration of a TMR component so that a low holding power property may be acquired more.
[0105] A graphic form on which two angles in which the rectangle of (b) other than the rectangle pattern with which the corner of (a) is radicalized enough carries out a vertical angle were dropped is also considered that a low holding power property is acquired comparatively so that the graph of the joint configuration of drawing 5 and the relation of holding power may show.
[0106] the joint configuration of drawing 5 as shown in (b) is shown in drawing 39 R> 9 -- as -- a line -- it can obtain correctly as a joint 81 shown in the slash section by repeating formation and dry etching of patterns 82, 83, and 84 3 times. such [ further again ] a line -- by repeating pattern formation and etching two or more times, it is very accurate and it is also possible to acquire the junction configuration of such convex polygons.
[0107] such a line of multiple times -- up to a joint [ like the 4th operation gestalt ] whose process of

pattern formation and dry etching is -- a line -- a mask layer like an approach and the 5th operation gestalt etched by the pattern -- a line -- it is clear that it is applicable to both approaches of etching by the pattern or the approach of the concomitant use.
[0108] When using the technique of the above-mentioned multiplet-line-like pattern formation for formation of two or more TMR components arranged in the shape of a grid in MRAM further again, the efficiency of a lithography process can be made to increase.
[0109] (7th operation gestalt) As 7th operation gestalt, the manufacture approach of the TMR component of the 2nd operation gestalt ( drawing 7 ) of this invention is explained. it is shown in drawing 40 -- as -- the 1st line -- in case a pattern 92 is formed by the photolithography, the hemicycle-like pattern 93 is added to the location of two points which becomes coincidence with a point pair elephant at the edge used as a rectangle by spot drawing of EB drawing. the line which can use the technique of the mix and match which performs a photolithography and EB lithography in piles, and has a semi-sphere-like projection in a part if the chemical sensitization mold resist which has sensibility is used for the electron ray and far-ultraviolet light which are called SAL601 grade as a resist at this time -- a pattern 91, i.e., a TMR component, can be formed.
[0110] Here, generally, although a process throughput is a low process, EB lithography can draw a pattern with a diameter of 50nm at a high speed very much, if only the above spot drawing becomes. For example, if spot drawing is performed with the BI 1 MU current of 100pA(s) using SAL601 resist of a chemical sensitization mold, it is possible to draw about 109 spots corresponding to memory space 1Gb1t in **** or several minutes. therefore, the line of about 0.1-micrometer width of face by the photolithography -- pattern exposure and spot exposure with a diameter [ by EB lithography ] of about 50nm -- constructing -- ******** -- MRAM of lGbit is producible with sufficient productivity with things.
[0111] The above-mentioned ferromagnetic tunnel junction is applicable to a magnetic-recording component, a magneto-resistive effect mold magnetic head, magnetic-reproducing equipment, etc. Hereafter, the operation gestalt of the application of the magneto-resistive effect component of this invention is explained.
[0112] (8th operation gestalt) The 8th operation gestalt explains the example which applied the magneto-resistive effect component of this invention to the magnetic recording medium (MRAM).
[0113] Generally, in MRAM, to be large capacity in a small die size is demanded. Therefore, the area of each cel cannot but become small inevitably not to mention wiring width of face. However, since a switching magnetic field can be reduced by using the magneto-resistive effect component of this invention. It is small and ends, and power consumption is stopped and the high-speed switching of a write-in current required in the case of the writing of a storage bit is attained. Therefore, the magnetic cell of this invention is suitable to use for the cel of MRAM.
[0114] A sectional view for drawing 41 to explain the configuration of the record component according to individual and drawing 42 are the ** type-circuit diagrams of MRAM.
[0115] MRAM is equipped with two or more read-out word lines WL1 (122) controlled by the low decoder 140, and two or more bit lines BL (134) which are controlled by column DEDA 150 and intersect a word line 122 as shown in drawing 42 . Each intersection of a word line 122 and a bit line 134 is equipped with MOSFET120 as the magneto-resistive effect component (for example, 10, 20, 30 and 40 of the 3rd operation gestalt, or 91 grades of the 7th operation gestalt) of this invention, and a switch (flow controlling element) with which the flow is controlled by the word line 122. Moreover, it has the write-in word line WL2 (131) which approaches a magnetic resistance element 10 in parallel with the read-out word line 122, and extends.
[0116] Each memory device is constituted like drawing 40 . MOSFET120 is formed in the front face of a semi-conductor substrate. 123,124 is a source drain field, and the gate electrode 122 extends, is formed and serves as a word line WL1 (122). Through the contact 132 of a source drain field connected to 124 on the other hand, the substrate wiring 133 is formed and the magnetic resistance effectiveness component 10 of this invention is formed between this substrate wiring 133 and a bit line 134. Moreover, it approaches and writes in the magneto-resistive effect component 10, and the word line

WL2 (131) of business is formed.
[0117] In addition, MRAM may be laminating-constituted by using diode as the magneto-resistive effect component of this invention instead of an MOS transistor. That is, on a word line, the laminating of the cel which consists of a magneto-resistive effect component of diode and this invention is carried out, it is formed, a bit line is arranged and formed on a magneto-resistive effect component, and MRAM can consist of arranging a majority of this cel in the shape of an array further. Such MRAM can be carried in the memory section of gestalt terminals, such as a cellular phone.
[0118] (9th operation gestalt) The 9th operation gestalt explains the example which applied the magneto-resistive effect component of this invention to the magnetic head.
[0119] Drawing 43 is the perspective view of a magnetic-head assembly which carried the magneto-resistive effect component 10 (you may be 20, 30, 40, and 91) of the 3rd operation gestalt. An actuator arm 301 has the bobbin section which the hole for being fixed to the fixed shaft in a magnetic disk drive is prepared, and holds the drive coil which is not illustrated. The suspension 302 is being fixed to the end of an actuator arm 301. At the tip of a suspension 302, the writing of a signal and the lead wire 304 for reading are wired, the end of this lead wire 304 is connected to each electrode of the magneto-resistive effect component 10 included in the head slider 303, and the other end of lead wire 304 is connected to the electrode pad 305.
[0120] Drawing 44 is the perspective view showing the internal structure of the magnetic disk drive (magnetic-reproducing equipment) which carried the magnetic-head assembly shown in drawing 43 . A spindle 312 is equipped with a magnetic disk 311, and it rotates by the motor which answers a control signal from the driving gear control section which is not illustrated and which is not illustrated.
[0121] It is fixed to the fixed shaft 313 and the actuator arm 301 is supporting the suspension 302 and the head slider 303 at the tip. If a magnetic disk 311 rotates, the medium opposed face of the head slider 303 will be held where specified quantity surfacing is carried out from the front face of a magnetic disk 311, and will perform informational record playback.
[0122] The voice coil motor 314 which is a kind of a linear motor is formed in the end face of an actuator arm 301. The voice coil motor 314 consists of magnetic circuits which consist of a permanent magnet countered and arranged so that the drive coil which was able to be wound up in the bobbin section of an actuator arm 301, and which is not illustrated, and this coil may be put, and opposite York.
[0123] An actuator arm 301 is supported by the ball bearing which was prepared in two upper and lower sides of the fixed shaft 313 and which is not illustrated, and has come to be able to perform rotation sliding free with a voice coil motor 314.
[0124] The actuation and large-capacity-izing which were stabilized at high speed from the conventional magneto-resistive effect component by the magnetic head or magnetic-reproducing equipment which used the magneto-resistive effect component of this invention as mentioned above are attained.
[0125]
[Effect of the Invention] In the magneto-resistive effect component of this invention, coercive force is small and a switching magnetic field is small. When this component is used as a memory cell of magnetic memory, the write-in wiring current for generating a magnetic field required for flux reversal can be made small. Therefore, by the magnetic memory which used the magnetic cell of this invention as the memory cell, the thing which can be integrated highly and reduces power consumption and for which a switching rate is accelerated both becomes possible.
[0126] Moreover, according to the manufacture approach of the magneto-resistive effect component of this invention, the above-mentioned component can be manufactured with the sufficient yield in an easy process.

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[Translation done.]

* NOTICES *



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DRAWINGS

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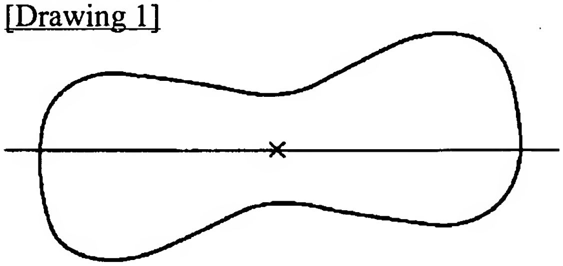
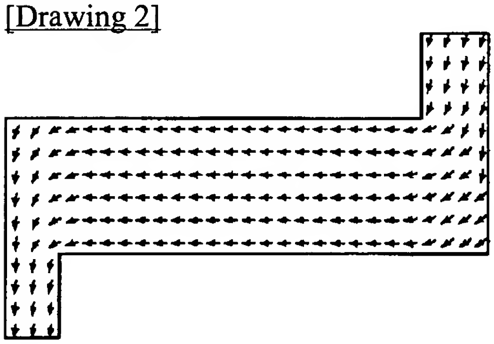
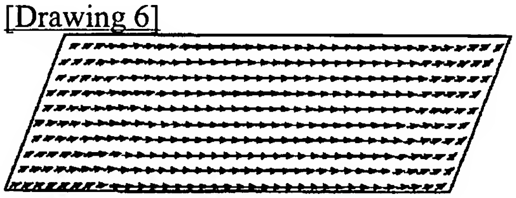
[Drawing 1]



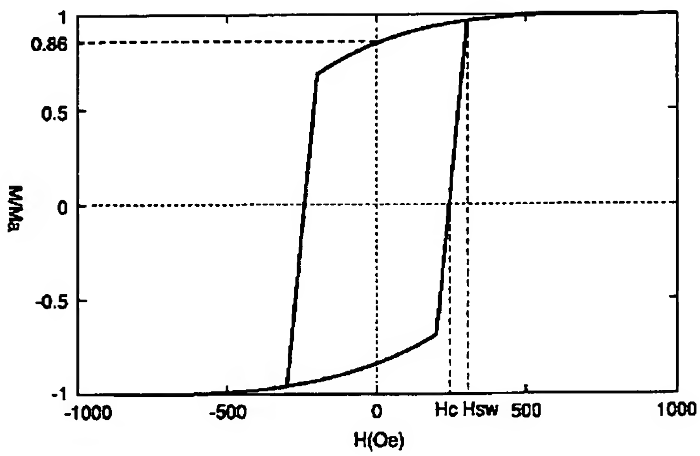
[Drawing 2]



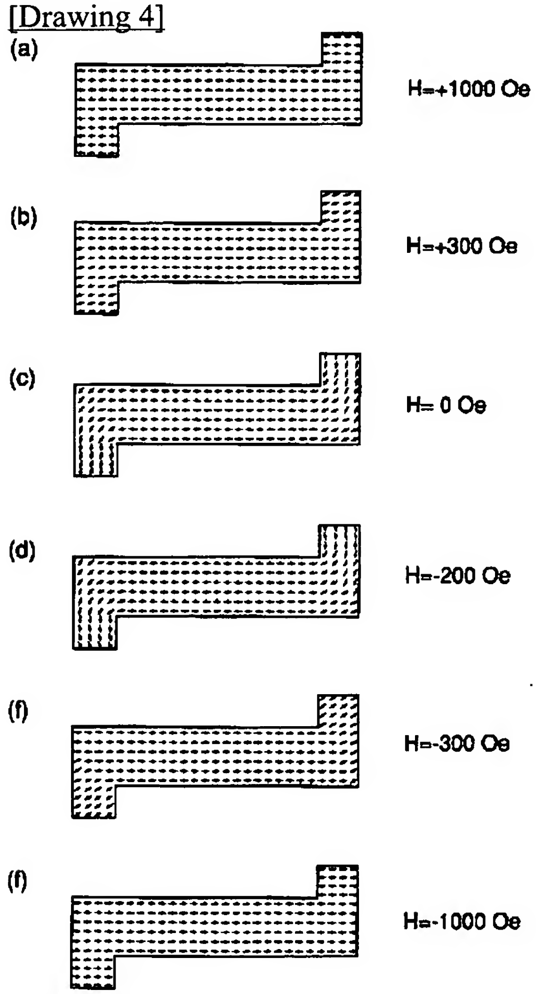
[Drawing 6]



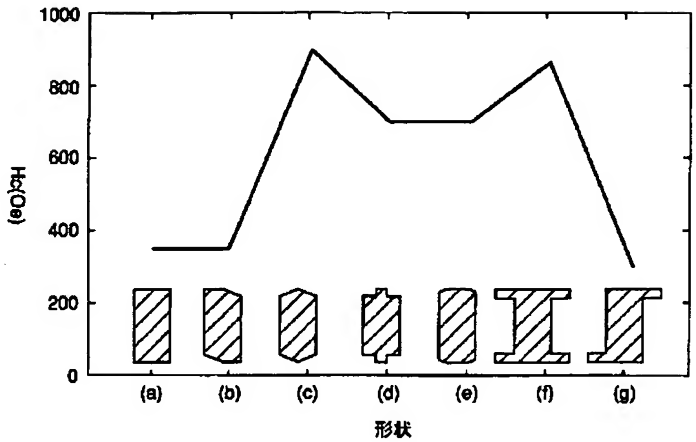
[Drawing 3]



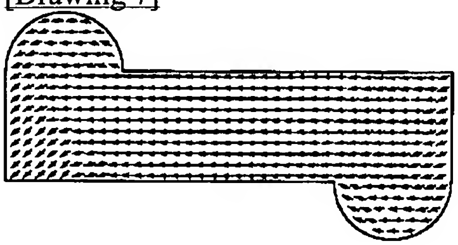

[Drawing 4]



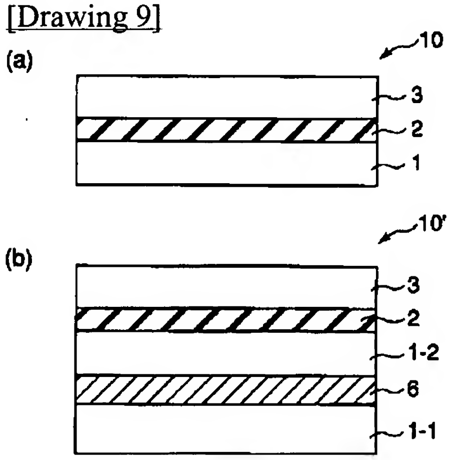

[Drawing 5]



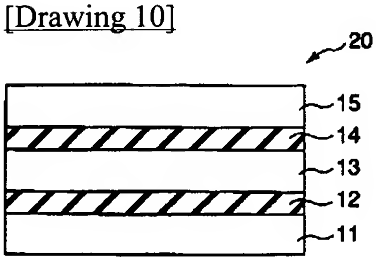

[Drawing 7]



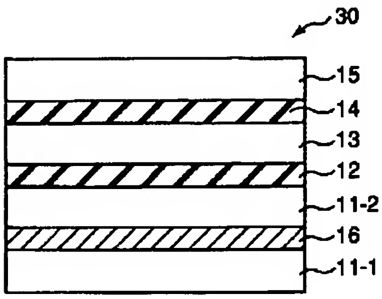
[Drawing 9]



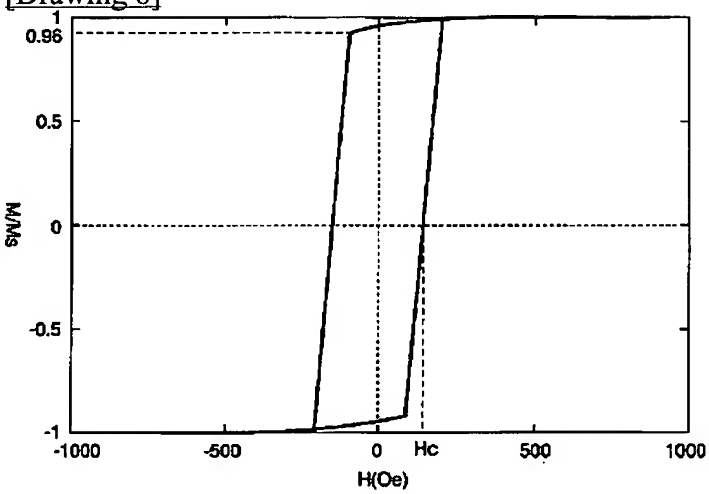

[Drawing 10]



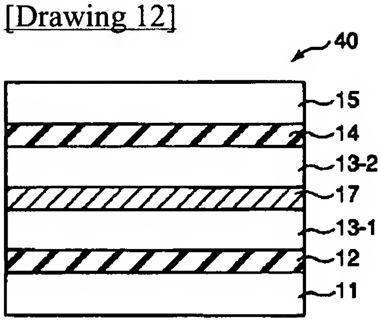

[Drawing 11]



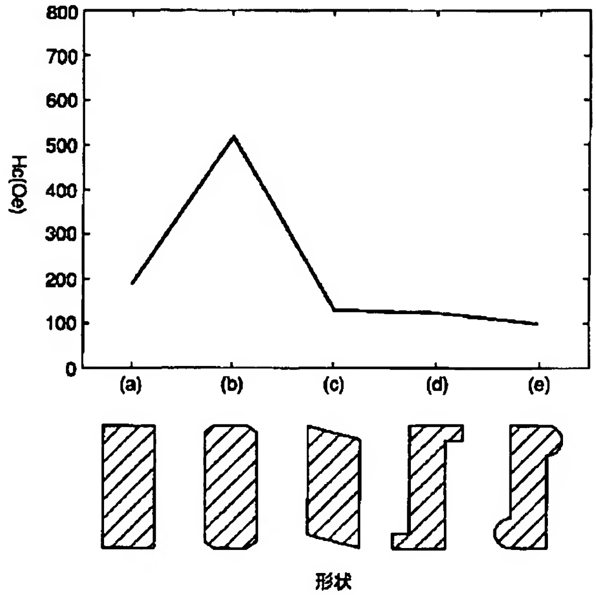

[Drawing 8]



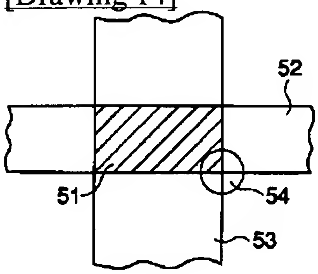

[Drawing 12]



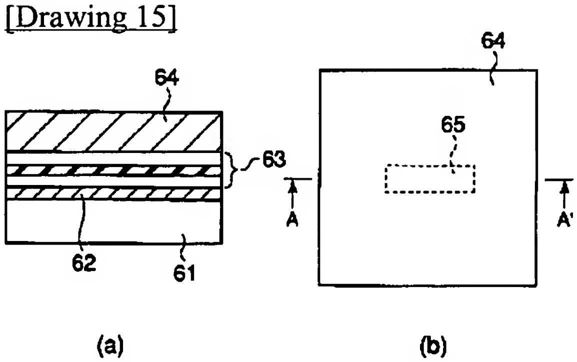

[Drawing 13]



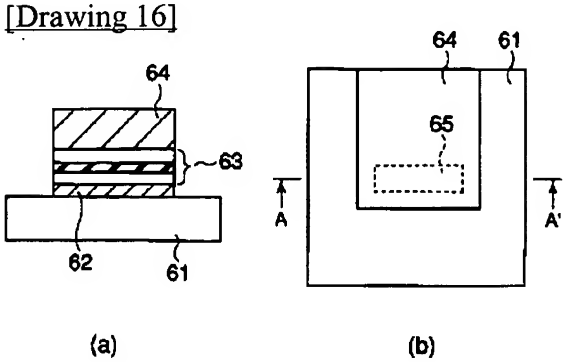

[Drawing 14]



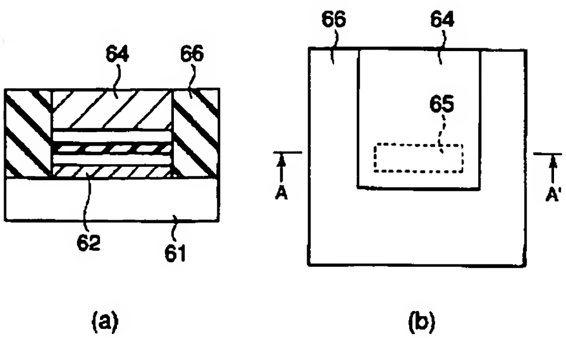

[Drawing 15]



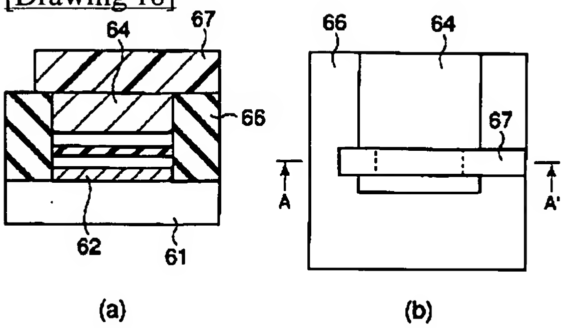

[Drawing 16]



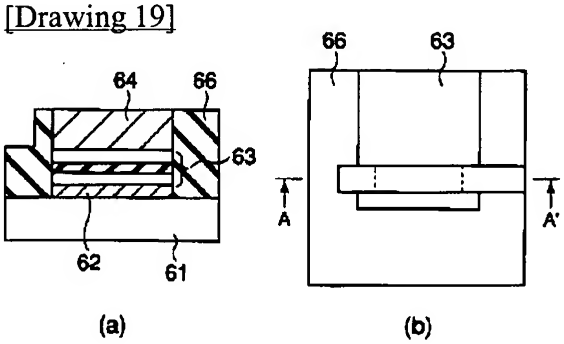

[Drawing 17]



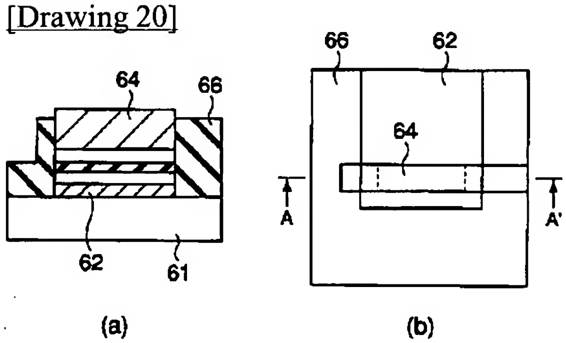

[Drawing 18]



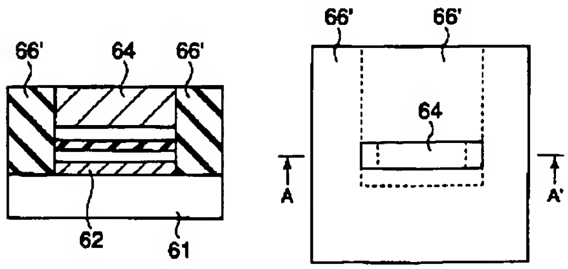

[Drawing 19]




[Drawing 20]

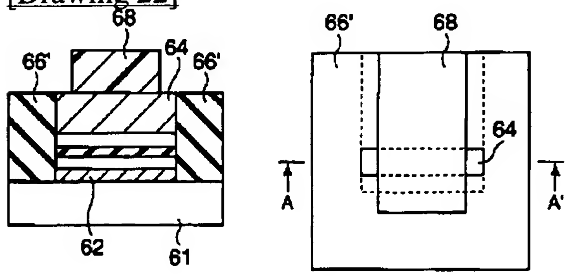



[Drawing 21]



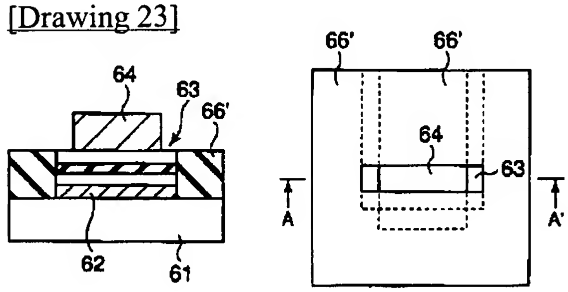

(a) (b)

[Drawing 22]



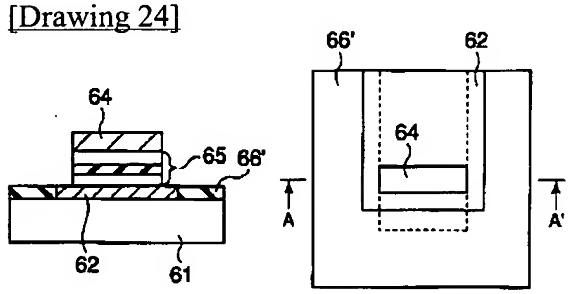

(a) (b)

[Drawing 23]



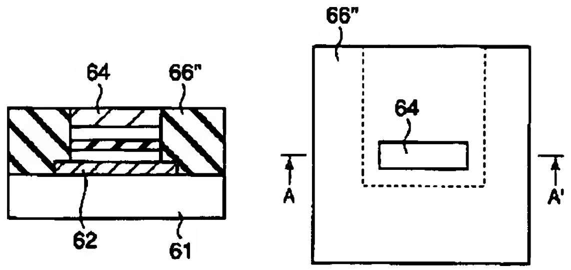

(a) (b)

[Drawing 24]



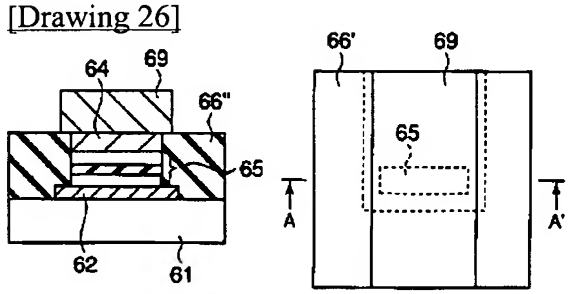

(a) (b)

[Drawing 25]



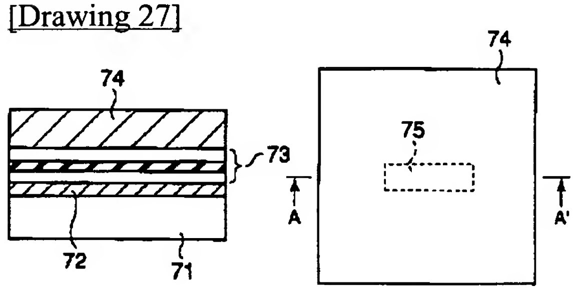

(a) (b)

[Drawing 26]



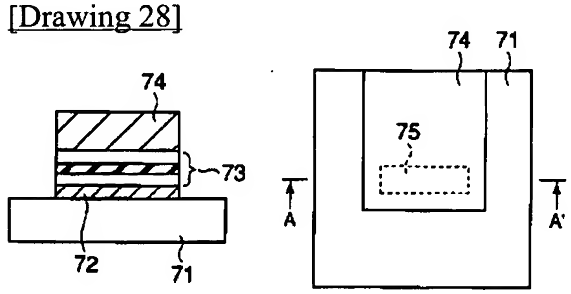

(a) (b)

[Drawing 27]



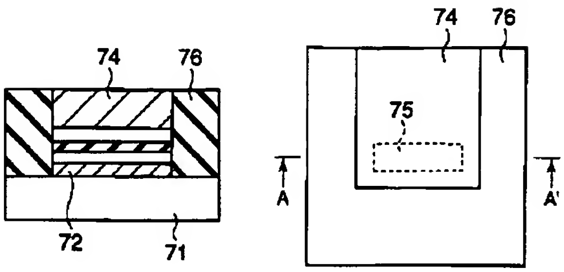

(a) (b)

[Drawing 28]



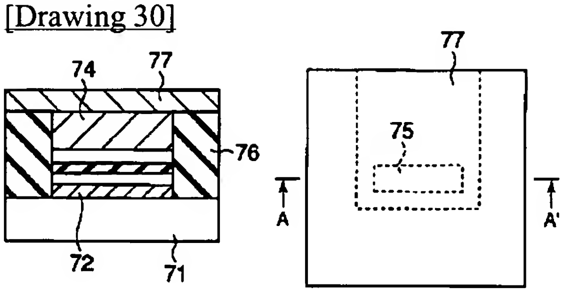

(a) (b)

[Drawing 29]



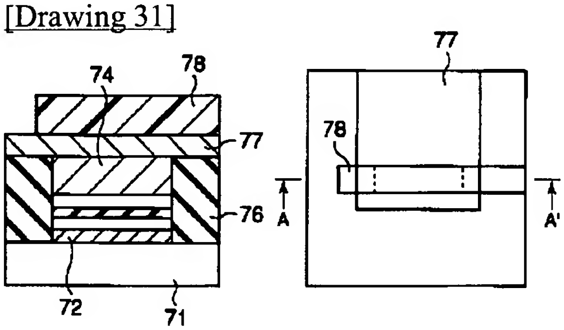

(a) (b)

[Drawing 30]



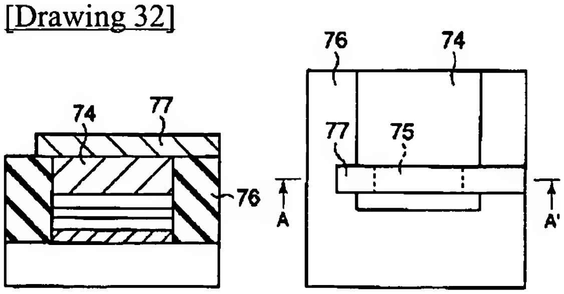

(a) (b)

[Drawing 31]



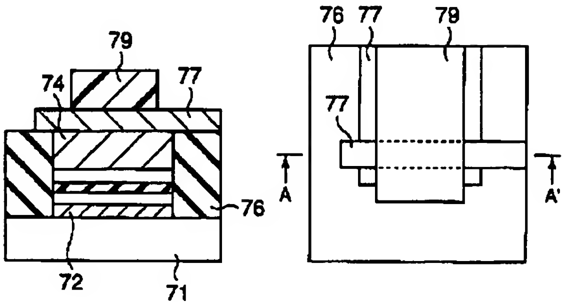

(a) (b)

[Drawing 32]



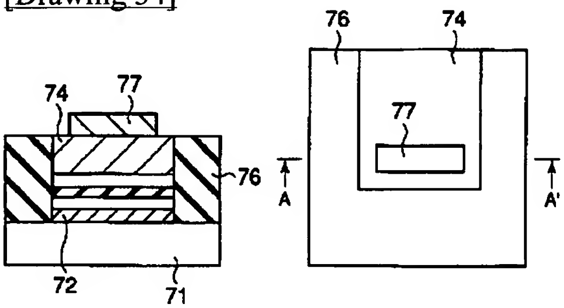

(a) (b)

[Drawing 33]



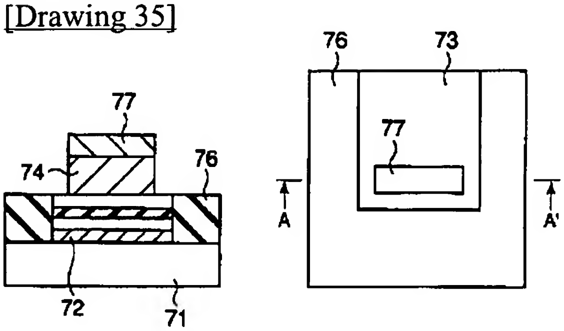

(a) (b)

[Drawing 34]



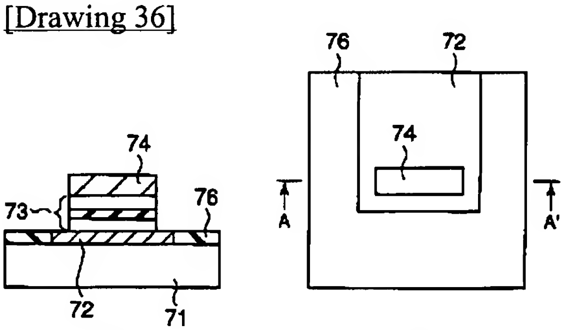

(a) (b)

[Drawing 35]



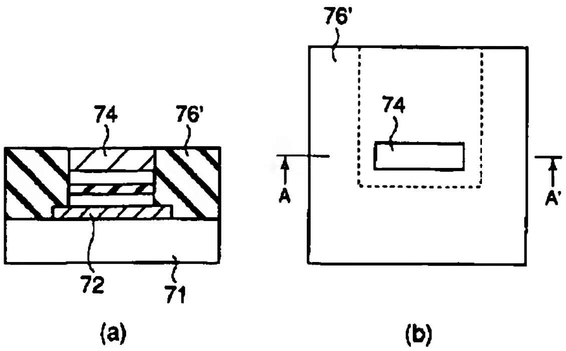

(a) (b)

[Drawing 36]

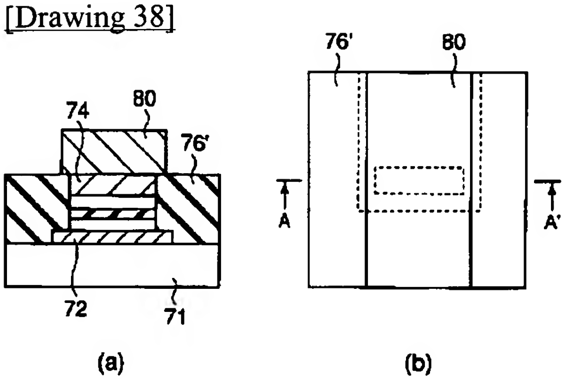



(a) (b)

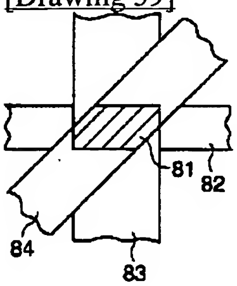
[Drawing 37]



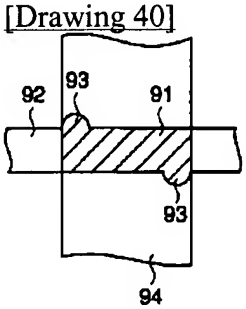

[Drawing 38]



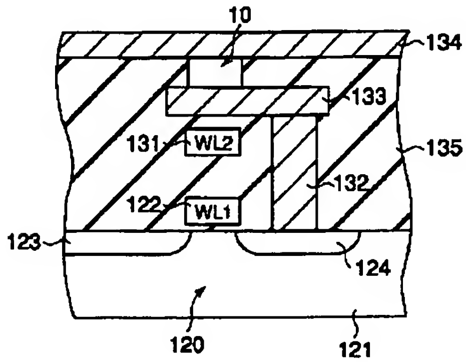

[Drawing 39]



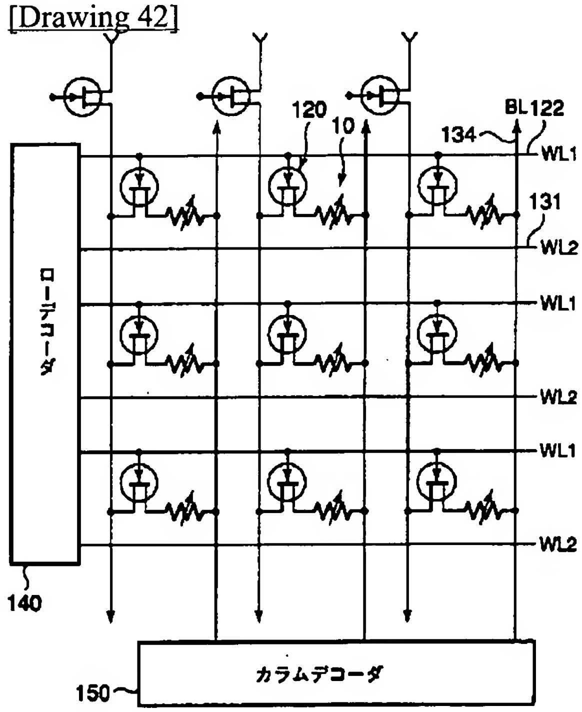

[Drawing 40]



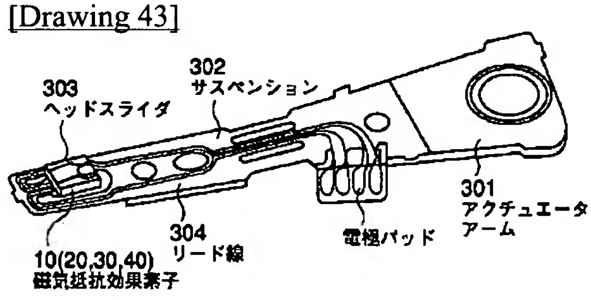

[Drawing 41]



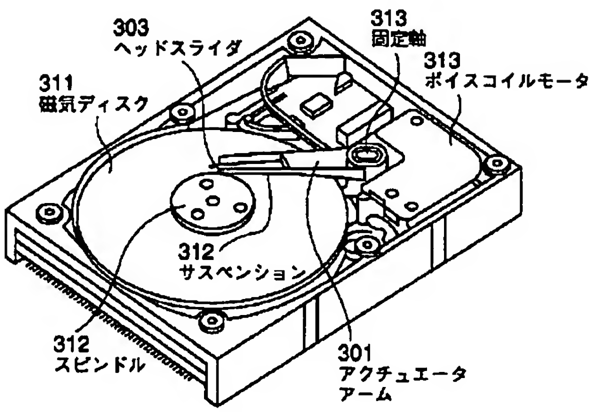

[Drawing 42]



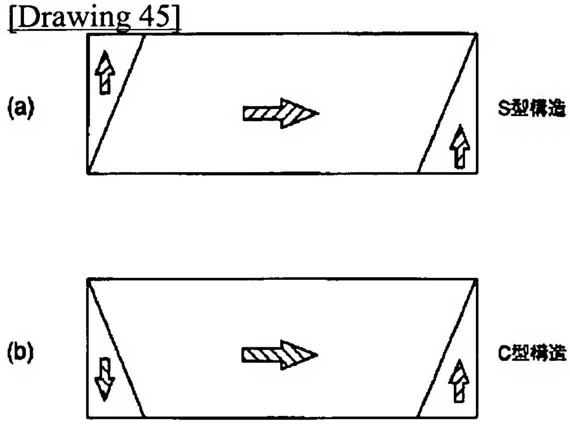

[Drawing 43]




[Drawing 44]

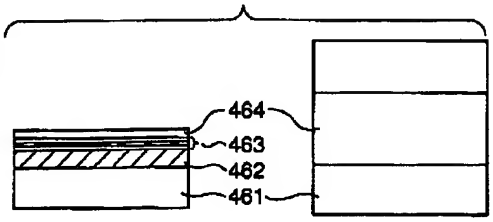



[Drawing 45]

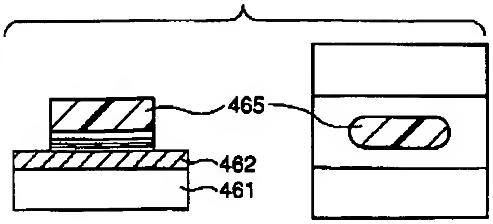



[Drawing 46]

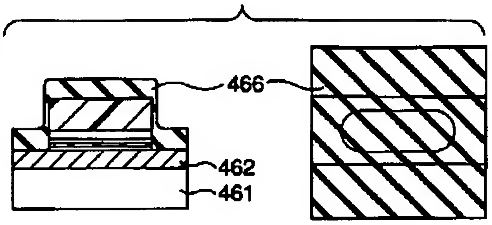
(a)



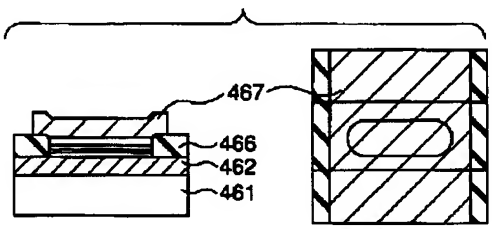

(b)




(c)




(d)

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[Translation done.]